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Six Species of *Lamellodiscus* (Monogenea: Diplectanidae) Collected from Australian Bream (*Acanthopagrus* spp.)

By

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With Text-figures 1–7 and Tables 1–10

Abstract Six *Lamellodiscus* species are recorded from Australian bream, i.e. *Acanthopagrus butcheri* (Munro), *A. australis* (Gunther), *A. berda* (Forskal) and *A. latus* (Houttuyn) from around Australia. New species include *Lamellodiscus vaginalis, L. butcheri* and *L. cirrusspiralis*. Previously described species include *L. acanthopagri* Roubal, *L. squamosus* Roubal and *L. major* Murray.

From May 1982 to January 1983, I collected and examined approximately 1000 fishes of four species of bream (*Acanthopagrus* spp.) from 22 localities around Australia (see Fig. 7), to assess the ectoparasite fauna of the economically important bream. To date, four species of Polylabroides have been described (Byrnes, 1985), as well as a single species of *Benedenia, Haliotrema, Allomurraytrema, Anoplodiscus* and *Udonella* (Byrnes, in press). In this paper 6 species of *Lamellodiscus* are recorded, 3 of which are new to science.

The only previous records of *Lamellodiscus* species from Australian waters are those given in Johnston & Tiegs (1922), Murray (1931), Roubal (1981) and Roubal *et al.* (1983).

Most fish were collected by rod and reel, a small portion by net and an even smaller percentage with a hand spear. Samples of forty fish per site were collected from the localities shown in (Fig. 7). Fish from Coffs Harbour were collected and examined by Roubal (1981).

Immediately after capture fish were killed, their ventral side was slit open, and they were dropped into cold 10% formalin. The body surface, fins, head, nares, mucous cavities, opercular and buccal cavities, pseudobranchs, individual gill flaments and gill arches of each fish were examined under a dissecting microscope. The sediment was also examined. Monogeneans were stored in 10% formalin, washed overnight in distilled water and stained in Grenacher's alum carmine, according to the method given in Romeis (1948), and in Delafield's haematoxylin (Humason, 1962). Sclerotinized elements were more easily examined in specimens cleared in lactic acid for up to two weeks and mounted in polyvinyl lactophenol.

All specimens were measured with the aid of a calibrated occular micrometer; values are given in micrometers as mean (range) and length-width. All drawings were made with the aid of a camera lucida.

Prevalence is defined as the percentage of individuals of a host infected with a particular parasite species. Relative density is defined as the total number of individuals of a particular parasite species in a sample of hosts — total number of individuals of the host species (infected and uninfected) in the sample examined.

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Family Diplectanidae Bychowsky
Genus *Lamellodiscus* Johnston & Tiegs

Lamellodiscus vaginalis, sp. nov.

(Fig. 1)

Material. Six thousand four hundred and forty specimens collected. Holotype and five paratypes from *A. butcheri* at Melbourne, deposited in Australian Museum (W198992 and W198993). Site: Gill filaments. Hosts: *A. butcheri* and *A. australis*. Localities: Perth, Stokes Inlet, Port Lincoln, Coorong, Melbourne, Lakes Entrance, Swansea, and Eden. See Table 8 for prevalence and relative densities; and Fig. 7 for distribution.

Measurements based on ten specimens from Melbourne. For additional measurements see Table 1. Body elongate, 400 (332–457) long (excluding anchors). Maximum body width 122 (108–133) at level of ovary. Part of body between lamellodiscs

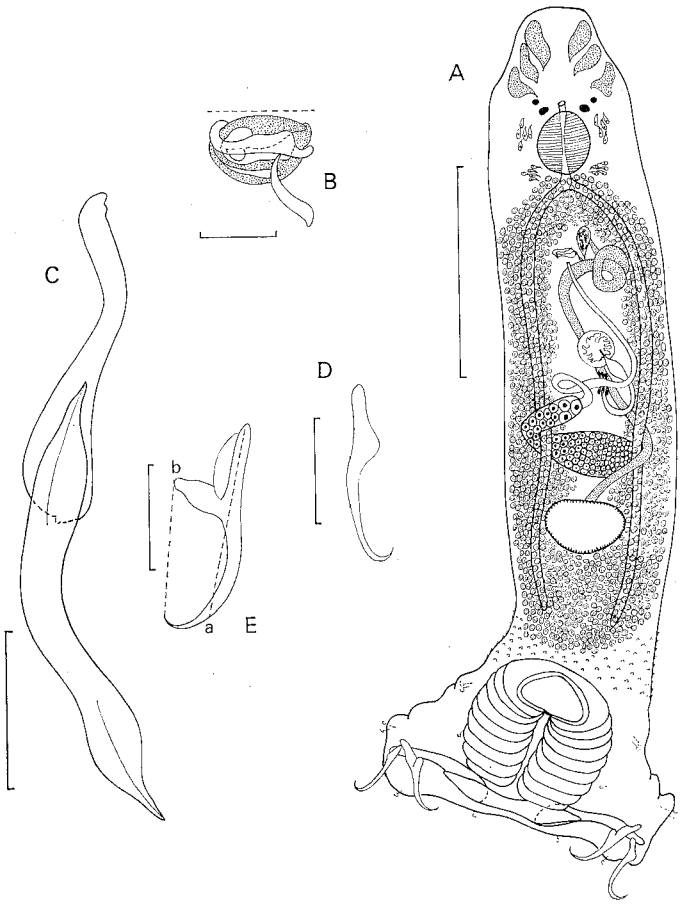


Fig. 1. *Lamellodiscus vaginalis*, sp. nov. A. Entire animal, ventral; B. Copulatory sclerites, ventral; C. Central and lateral crossbars, ventral; D. Ventral anchor, ventral; E. Dorsal anchor, ventral: measurement scheme (a, b). Scale lines: A, 100 μm; B, 20 μm; C, 35 μm; D, E, 25 μm.

Table 1. Measurements (mean (range)) of *Lamellodiscus vaginalis* on two species of *Acanthopagrus* at various localities. (L=maximum length; W=maximum width; N=number of specimens measured). For abbreviations of localities see Fig. 7.

Host		*A. australis*	*A. butcheri*					
Localities		E (N=10)	M (N=10)	PL (N=10)	LE (N=10)	P (N=10)	SI (N=10)	S (N=10)
Total	L	415(374–457)	400(332–457)	429(374–473)	390(349–457)	411(374–457)	419(374–457)	417(374–452)
Max. width		113 (91–125)	122(108–133)	107 (91–125)	114(100–125)	122 (81–125)	114(100–141)	113(100–141)
Opisthaptor	W	190(183–208)	191(166–199)	190(183–208)	189(166–208)	194(183–208)	181(166–199)	199(183–208)
Lamellodisc	L	71 (61–81)	79 (67–91)	67 (61–71)	69 (61–85)	74 (67–83)	72 (55–83)	67 (61–73)
	W	81 (71–91)	83 (71–91)	78 (71–87)	78 (67–95)	75 (61–91)	79 (67–91)	80 (71–101)
Central crossbar	L	97 (91–103)	102 (99–109)	98 (91–103)	98 (91–107)	93 (87–99)	93 (87–99)	97 (91–101)
Lateral crossbar	L	78 (75–81)	80 (75–85)	78 (73–81)	78 (71–83)	75 (71–83)	74 (61–81)	78 (73–81)
Ventral anchor	A	40 (34–45)	38 (34–41)	33 (20–41)	39 (38–43)	42 (30–47)	40 (38–43)	37 (30–41)
	B	39 (32–45)	37 (32–41)	30 (16–38)	39 (36–43)	39 (28–43)	40 (36–41)	32 (26–38)
Dorsal anchor	A	44 (38–49)	44 (38–51)	46 (41–51)	47 (41–51)	49 (45–55)	46 (38–55)	45 (38–51)
	B	42 (32–47)	45 (41–51)	43 (36–49)	45 (38–51)	48 (43–53)	44 (34–53)	41 (34–49)
Copulatory sclerites	L	27 (22–32)	28 (24–34)	26 (20–30)	28 (20–34)	26 (22–30)	28 (24–30)	25 (20–30)
Pharynx	L	43 (38–55)	45 (41–51)	39 (36–45)	43 (38–49)	43 (38–47)	43 (38–49)	40 (36–45)
	W	38 (30–45)	44 (38–51)	36 (26–41)	42 (36–51)	38 (34–45)	39 (32–45)	35 (32–41)

and tips of caeca covered with small scales.

Opisthaptor 191 (166–199) wide with truncated posterior margin. Two pairs of anchors situated posterolaterally, connected by three crossbars. Dorsal pair of anchors (Fig. 1–E) with two large basal roots of unequal size. Ventral anchor (Fig. 2–E) with one large and one vestigial root. Measurements for anchors as follows: (see Fig. 1–E: a and b for measurement scheme).

	Measurement
Dorsal anchor	Ventral anchor
A 44 (38–51)	38 (34–41)
B 45 (41–51)	37 (32–41)

Three crossbars (Fig. 1–C) across entire posterior margin of opisthaptor. Central bar arched anteriorly, 102 (99–109) long; subterminal regions enlarged slightly, tapered terminally. Two lateral bars, each 80 (75–85) long; median regions enlarged; middle parts arched anteriorly and slightly sinuous. Fourteen hooklets arranged as shown (Fig. 1–A); each 10 (9–12) long. Dorsal and ventral lamellodiscs large, 79 (67–91)×83 (71–91), each covers entire median section of opisthaptor and extends slightly onto body proper. Each lamellodisc with eighteen plates.

Three pairs of head organs along anterolateral margins of body. Pharynx 45 (41–51)×44 (38–51). Mouth opening between two pairs of eye spots. Lateral digestive glands at end of pharynx. Intestinal bifurcation immediately posterior to pharynx; caeca simple, not confluent posteriorly. Vitellaria coextensive with caeca and filling intercaecal region posterior to testis.

Single median, postovarian testis. Sperm duct loops around left caecum, passes sinuously forward and enlarges to seminal vesicle. Two complex copulatory sclerites and one simple sclerite 28 (24–34) long (Fig. 1–B). Prostatic complex anterior to sclerites.

Ovary looped around right caecum, germinal region dorsal and slightly posterior to ventral anterior end. Oviduct leaves anterior end of ovary, passes short distance forward, forms a loop and passes to left where it enters ootype. Vagina medioventral, relatively large; sclerotinized vaginal duct between vagina and oviduct. Uterus passes to the left, then passes forward to gonopore located ventral to copulatory sclerites.

Etymology. The name *vaginalis* refers to the unusually large flower-like vagina in this species.

Discussion. This species is morphologically closest to *L. squamosus* Roubal, 1981, which was also found in this study, and *L. coronatus* Euzet et Oliver, 1966. However, in addition to obvious differences in body and organ sized, (Tables 1 and 5), *L. vaginalis* does not possess a hooked sclerite as does *L. squamosus*. Like the new species *L. coronatus* has a large sclerotinized vagina but the vagina of *L. coronatus* is much more laterally positioned. There are also differences in the structure of the

opisthaptor.

Differential Diagnosis. This species differs from other species in the combination of the following characteristics: shape of the copulatory sclerites, the large flower-like sclerotinized vagina, and the shape of the haptorial armature.

Lamellodiscus butcheri, sp. nov.

(Fig. 2)

Material. Three thousand and sixty-six specimens collected. Holotype and five paratypes from *A. butcheri* at Melbourne, deposited in Australian Museum (W198990 and W198991). Site: Gill filaments. Hosts: *A. butcheri* and *A. australis*. Localities: Melbourne, Lakes Entrance, Swansea, Eden, Perth, Port Lincoln, Stokes Inlet, and Coorong. See Table 9 for prevalence and relative densities; Fig. 7 for distribution.

Measurements based on ten specimens from Melbourne. For additional measurements see Table 2. Body smooth, flattened, only slightly tapered anteriorly. Total length (excluding anchors) 380 (332–415). Maximum body width 116 (108–133) at level of ovary.

Opisthaptor 126 (116–141) wide with truncated posterior margin. Two pairs of large anchors situated posterolaterally, connected by three crossbars. Dorsal pair of anchors (Fig. 2–D) with two large basal roots interconnected by sclerotinized sheath. Ventral anchor (Fig. 2–E) with single root enlarged laterally. Measurements of anchors as follows: (see Fig. 1–E for scheme of measurements).

Measurements

Dorsal anchor	Ventral anchor
A 52 (51–55)	40 (38–43)
B 46 (41–51)	36 (30–41)

Central crossbar (Fig. 2–C) 48 (43–55) long, with narrowed median section; enlarged subterminal sections tapered laterally as well as curved anteriorly. Two separate lateral bars (Fig. 8), each with 44 (41–49) long; median ends enlarged with tapered lateral regions. Seven pairs of hooklets arranged as shown (Fig. 2–A); each 10 (9–11) long. Dorsal and ventral lamellodiscs 39 (36–41) × 35 (30–41); each composed of eighteen plates.

Three pairs of head organs along anterolateral margins of body. Pharynx 30 (28–34) × 31 (28–33). Mouth ventral to anterior pair of eye spots. Lateral digestive glands empty into posterior end of pharynx. Intestinal bifurcation immediately posterior to pharynx; caeca simple, not confluent posteriorly. Vitellaris coextensive with caeca and filling intercaecal region posterior to testis.

Single median, postovarian testis. Sperm duct passes sinuously forward forming loop around left caecum and enlarges to seminal vesicle. Copulatory sclerites (Fig. 2–B) composed of two elements, running parallel to each other, 32 (24–36) long.

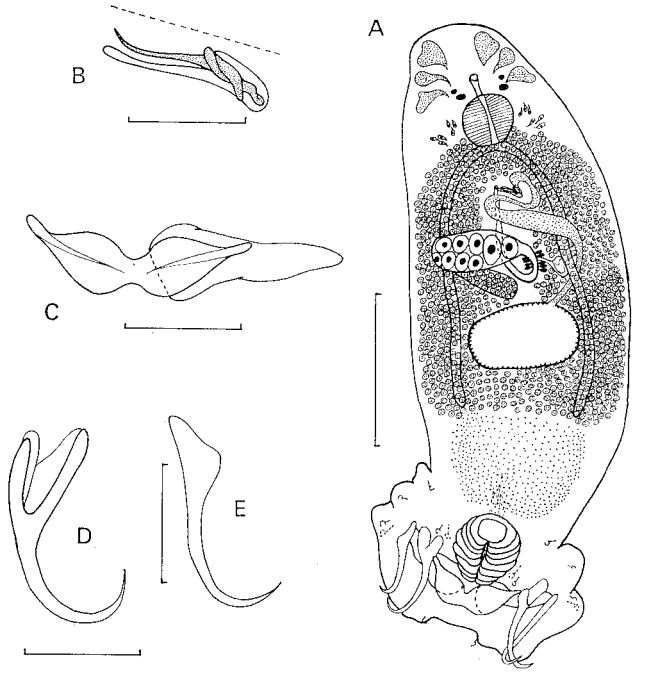


Fig. 2. *Lamellodiscus butcheri*, sp. nov. A. Entire animal, ventral; B. Copulatory sclerites, ventral; C. Central and lateral crossbars, ventral; D. Dorsal anchor, ventral; E. Ventral anchor, ventral. Scale lines: A, 100 μm; B, 20 μm; C, E, 25 μm; D, 30 μm.

Ovary looped around right caecum; germinal region dorsal and slightly posterior to ventral, anterior end. Oviduct leaves anterior end of ovary, passes short distance posteriorly where it enters ootype. Uterus passes forward to gonopore. Vagina opens dorsally to right of ovary.

Etymology. The name *butcheri* refers to the preferred host *A. butcheri.*

Discussion.. This species is most similar to *L. acanthopagri* Roubal (1981), which was also found in this study. However, in addition to obvious measurement differences (see Tables 2 and 4), *L. butcheri* clearly differs from *L. acanthopagri* in the shape of its anchors and copulatory sclerites. The anchors of *L. butcheri* are more robust and the dorsal anchor lacks the additional root flap displayed in *L. acanthopagri.* The copulatory sclerites of *L. butcheri* consist of two long components extending roughly parallel to each other, whilst those of *L. acanthopagri* are thickened and entwined in a complicated manner. The new species is also similar to *L. japonicus* Ogawa et Egusa, 1978, found on *Acanthopagrus schlegeli* but clearly differs in the shape of the vagina. *L. butcheri* possesses a simple shallow cup-like vagina while that of *L. japonicus* is funnel and flame-shaped near its opening.

Differential Diagnosis. This species differs from other species in the combination of the following characteristics: large, broad anchors, relatively small lamellodiscs,

Table 2. Measurements (mean (range)) of *Lamellodiscus butcheri* on two species of *Acanthopagrus* at various localities. (L=maximum length; W=maximum width; N=number of specimens measured). For abbreviations of localities see Fig. 7.

Host		*A. australis*	*A. butcheri*					
Localities		E (N=10)	M (N=10)	PL (N=10)	LE (N=10)	P (N=10)	SI (N=10)	S (N=10)
Total	L	394(307–457)	380(332–415)	395(332–415)	370(291–415)	385(332–451)	367(332–415)	431(332–498)
Max. width		126(108–149)	116(108–133)	132(108–158)	120 (83–158)	123(108–158)	121(108–141)	135(106–208)
Opisthaptor	W	126(108–133)	126(116–141)	134(125–141)	126(108–141)	135(125–141)	133(125–141)	123(116–141)
Lamellodisc	L	39 (34–41)	39 (36–41)	44 (41–47)	40 (34–51)	42 (38–43)	40 (38–47)	43 (41–49)
	W	35 (30–41)	35 (30–41)	37 (32–41)	37 (34–41)	36 (30–41)	35 (30–41)	35 (34–38)
Central crossbar	L	49 (45–53)	48 (43–55)	56 (48–61)	51 (43–57)	51 (41–57)	51 (41–55)	54 (49–57)
Lateral crossbar	L	45 (41–51)	44 (41–49)	47 (41–55)	47 (43–51)	47 (41–57)	44 (40–47)	43 (38–49)
Ventral anchor	A	43 (38–51)	40 (38–43)	50 (45–53)	43 (36–49)	46 (41–51)	42 (36–47)	47 (41–51)
	B	39 (30–49)	36 (30–41)	44 (38–47)	38 (30–45)	40 (34–45)	37 (32–41)	43 (30–51)
Dorsal anchor	A	52 (51–55)	52 (51–55)	60 (55–63)	56 (49–65)	54 (49–61)	54 (49–57)	58 (55–61)
	B	48 (41–57)	46 (41–51)	56 (51–61)	50 (41–61)	48 (41–57)	48 (41–51)	53 (41–61)
Copulatory sclerites	L	31 (20–41)	32 (24–36)	41 (34–47)	29 (26–34)	32 (24–41)	28 (24–34)	36 (32–41)
Pharynx	L	29 (26–34)	30 (28–34)	34 (29–41)	30 (26–36)	37 (28–41)	31 (22–34)	31 (28–34)
	W	30 (24–34)	31 (28–33)	31 (24–35)	30 (24–33)	29 (26–33)	31 (28–33)	44 (36–51)

and the shape of the copulatory sclerites.

Lamellodiscus cirrusspiralis, sp. nov.

(Fig. 3)

Material. Two hundred and two specimens collected. Holotype and five paratypes from *A. latus* at Point Samson, deposited in Australian Museum (W198994). Site: Gill filaments. Hosts: *A. berda* and *A. latus*. Localities: Lucinda, Darwin, Daintree, Broome, Point Samson, and Carnarvon. See Table 10 for prevalence and relative densities; Fig. 7 for distribution.

Measurements based on ten specimens from Point Samson. For additional measurements see Table 3. Body (Fig. 3–A) flattened, smooth, 392 (206–498) long (excluding anchors). Maximum body width 173 (166–191) at level of testis.

Opisthaptor 187 (183–199) wide with truncated posterior margin. Two pairs of anchors situated posterolaterally, connected by three crossbars. Dorsal pair of anchors (Fig. 3–D) with two large basal roots, largest root with sclerotinized sheath; ridge near base of shaft. Ventral anchor (Fig. 3–F) with single root enlarged

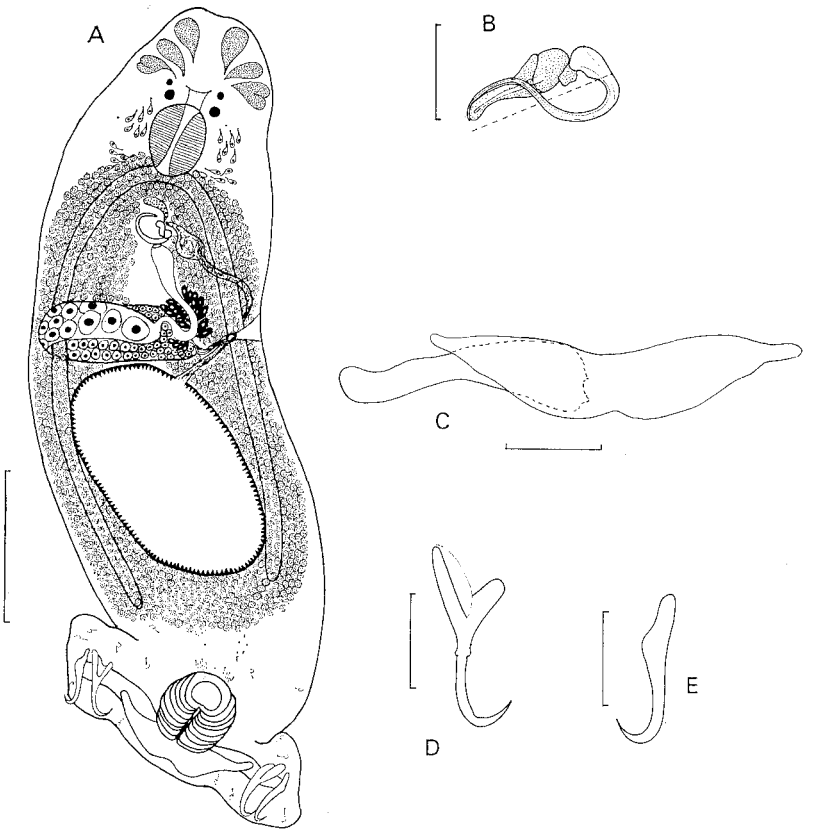


Fig. 3. *Lamellodiscus cirrusspiralis*, sp. nov. A. Entire animal, ventral; B. Copulatory sclerites, ventral; C. Central and lateral crossbars, ventral; D. Dorsal anchor, ventral; E. Ventral anchor, ventral. Scale lines: A, 100 μm; B–E, 25 μm.

Table 3. Measurements (mean (range)) of *Lamellodiscus cirrusspiralis* on two species of *Acanthopagrus* at various localities. (L=maximum length; W=maximum width; N=number of specimens measured). For abbreviations see Fig. 7.

Host		*A. berda*			*A. latus*		
Localities		L (N=1)	DW (N=2)	D (N=10)	PS (N=10)	BM (N=10)	CN (N=10)
Total	L	415	403(390–415)	378(291–457)	392(206–498)	424(374–556)	382(291–457)
Max. width		183	170(166–174)	177(125–216)	173(166–191)	161(141–181)	145(125–166)
Opisthaptor	W	183	183(174–191)	180(166–183)	187(183–199)	183(166–199)	185(166–208)
Lamellodisc	L	55	53 (49–57)	52 (45–55)	55 (49–61)	51 (47–61)	50 (45–55)
	W	47	47	47 (45–49)	51 (49–53)	48 (43–51)	49 (43–55)
Central crossbar	L	95	96 (91–101)	91 (87–97)	96 (91–105)	95 (89–107)	92 (85–101)
Lateral crossbar	L	71	71	71 (69–73)	72 (67–75)	71 (61–75)	70 (61–73)
Ventral anchor	A	41	43 (41–45)	42 (38–45)	43 (41–45)	43 (41–45)	40 (34–45)
	B	36	36 (34–38)	38 (34–51)	39 (34–41)	37 (34–41)	35 (28–41)
Dorsal anchor	A	51	48 (45–51)	48 (41–51)	49 (47–51)	49 (47–53)	49 (43–53)
	B	41	43 (41–45)	41 (36–45)	41 (38–45)	42 (36–47)	42 (30–53)
Copulatory sclerites	L	45	38	38 (36–71)	42 (30–71)	37 (30–41)	38 (30–49)
Pharynx	L	41	43 (41–45)	43 (36–45)	44 (41–49)	44 (41–49)	42 (30–55)
	W	34	30	30 (29–38)	37 (32–41)	34 (30–41)	32 (25–41)

laterally. Measurements for anchors as follows: (see Plate Fig. 1–E for scheme of measurements).

Measurements

Dorsal anchor	Ventral anchor
A 49 (47–51)	43 (41–51)
B 41 (38–45)	39 (34–41)

Central crossbar (Fig. 3–C) 96 (91–105) long, with narrowed median section; enlarged subterminal sections tapered laterally as well as curved anteriorly. Two separate lateral bars (Fig. 3–C), each 72 (67–75) long; median ends enlarged with tapered lateral regions. Seven pairs of hooklets arranged as shown (Fig. 3–A); each 10 (9–12) long. Dorsal and ventral lamellodiscs 55 (49–61) × 51 (49–53), each composed of two parallel rows with nine plates.

Three pairs of head organs along anterolateral margins of body. Pharynx 44 (41–49) × 37 (32–41). Mouth ventral to anterior pair of eye spots. Lateral digestive glands empty into posterior end of pharynx. Intestinal bifurcation immediately posterior to pharynx; caeca simple, not confluent posteriorly. Vitellaria coextensive with caeca and filling intercaecal region posterior to testis.

Single, large, posterovarian testis. Sperm duct loops around left caecum, passes forward and enlarges to seminal vesicle. Copulatory sclerites (Fig. 3–B) composed of two complex elements, 42 (30–71) long. One sclerite long, hollow and whip-like, other relatively stout and hollow.

Ovary looped around right caecum; germinal region dorsal and at same level as ventral, anterior end. Oviduct leaves anterior end of ovary, passes sinuously to the left of ovary, where it enters ootype and receives sclerotinized vaginal duct. Vagina lateroventral, opening above left caeca and forming a lateral invagination in body proper. Uterus passes forward and enlarges to gonopore, which is located posteroventral to copulatory sclerites.

Etymology. The name *cirrusspiralis* refers to the long spiral copulatory sclerite of the cirrus.

Discussion. This species possesses a very large testis which, like in *L. typicus* Johnston et Tiegs, 1922, can cause a bulge in the animal. However, aside from a large testis, *L. cirrusspiralis* has little in common with this parasite. *L. cirrisspiralis* is most similar to *L. drummondi* Euzet et Oliver, 1967. Both the new species and *L. drummondi* have a long looping copulatory sclerite. However, the latter species has a much smaller testis, relatively longer anchors, and a relatively shorter central crossbar. Also, the present species is unique in that its dorsal anchor has a thickened shaft with a distinct "step" or "ridge" produced near the centre of the anchor proper.

Differential Diagnosis. This species differs from other species in the combination of the following characteristics: a large testis, relatively short anchors, the

shape of the copulatory sclerites and a "step" or "ridge" near the centre of the ventral anchor.

Lamellodiscus acanthopagri Roubal

(Fig. 4)

Lamellodiscus acanthopagri Roubal, 1981, pp. 9, 10, figs 20–26.

Material. One thousand two hundred and fifty-seven specimens collected. Site: Gill filaments. Hosts: *A. australis*, *A. berda*, and *A. latus*. Localities: Newcastle, Coffs Harbour, Brisbane, Gladstone, Yeppoon, Townsville, Lucinda, Daintree, Karumba, Bing Bong, Darwin, Broome, and Point Samson. See Table 9 for prevalence and relative densities; Fig. 7 for distribution.

Previous Record. Roubal (1981) collected over two thousand specimens from *A. australis* at Coffs Harbour, N.S.W.

Roubal's description is adequate and needs no additions. For measurements see Table 4.

Discussion. Again, Roubal's material is longer and narrower than mine because it is not as strongly contracted due to the hot formalin for fixation. All other features are similar.

This species is the smallest monogenean of the study. It is most similar to *L. butcheri* described above. However, it is easily distinguished by the shape of the copulatory sclerites which are flattened and complicated in this parasite, but simple and tube-like in *L. butcheri*.

As with the other *Lamellodiscus* species described in this study, the sperm duct loops around the left caecum. Many *Lamellodiscus* species have been described in which this feature was not observed, see Euzet & Oliver (1966, 1967) and Oliver (1969, 1973).

Differential Diagnosis. The new species differs from other species in the shape

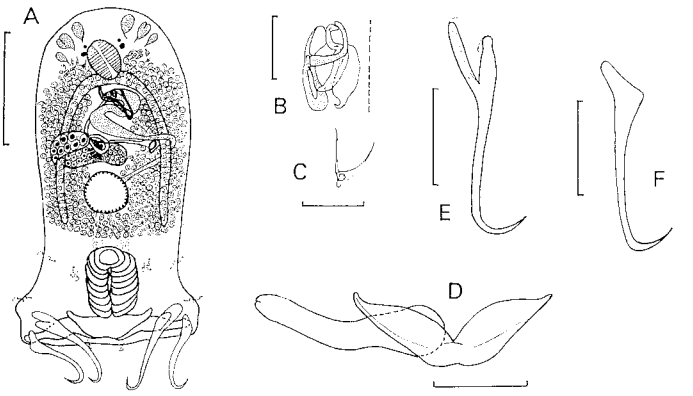


Fig. 4. *Lamellodiscus acanthopagri* Roubal. A. Entire animal, ventral; B. Copulatory sclerites, ventral; C. Vaginal sclerite; D. Central and lateral crossbar, ventral; E. Dorsal anchor, ventral; F. Ventral crossbar, ventral. Scale lines: A, 75 μm; B, C, 30 μm; D–E, 25 μm.

Table 4. Measurements (mean (range)) of *Lamellodiscus acanthopagri* on three species of of specimens measured. Measurements of specimens from CH are according

Host		*A. australis*			
Localities		N (N=10)	CH (N=10)	B (N=10)	G (N=10)
Total length	L	233(191–226)	306(265–330)	254(199–291)	263(249–291)
Max. width		105 (91–116)	56 (49–70)	103 (91–116)	102 (91–116)
Opisthaptor	W	119(108–141)	93 (86–103)	119(108–125)	115(108–125)
Lamellodisc	L	45 (35–51)	38 (29–44)	45 (38–47)	51 (41–45)
	W	41 (34–45)	33 (29–42)	42 (38–43)	42 (38–45)
Central crossbar	L	54 (51–57)	46 (34–54)	53 (49–57)	54 (51–57)
Lateral crossbar	L	47 (41–53)	37 (33–42)	47 (41–51)	48 (41–51)
Ventral anchor	A	49 (43–51)	52 (51–54)	49 (45–55)	52 (47–55)
	B	45 (41–51)	—	47 (41–51)	47 (43–51)
Dorsal anchor	A	62 (58–65)	62 (57–66)	61 (57–63)	62 (58–65)
	B	57 (53–61)	—	56 (53–61)	58 (55–65)
Copulatory sclerites	L	47 (36–55)	34 (27–42)	50 (45–55)	51 (41–55)
Pharynx	L	26 (24–30)	33 (20–24)	26 (20–28)	26 (20–30)
	W	22 (20–24)	20 (17–23)	22 (20–24)	23 (20–26)

of the copulatory and vaginal sclerites and the relatively large anchors.

***Lamellodiscus squamosus* Roubal**

(Fig. 5)

Lamellodiscus squamosus Roubal, 1981, pp. 11, 12, figs 27–33.

Material. Five hundred and twenty-four specimens collected. Site: Gill filaments. Hosts: *A. berda* and *A. latus*. Localities: Newcastle, Coffs Harbour, Brisbane, Townsville, Lucinda, Daintree, Bing Bong, Darwin, Broome, Point Samson, and Carnarvon. See Table 8 for prevalence and relative densities; Fig. 7 for distribution.

Previous Record. Roubal (1981) recovered forty specimens from *A. australis* at Coffs Harbour, N.S.W.

Roubal's description is adequate and needs no additions. For measurements see Table 5.

Discussion. These specimens are similar in every character to *L. squamosus* described by Roubal (1981) except for size of body proper and anchors. Roubal's material is markedly longer and narrower than specimens from this study. This can be explained by the different preservative methods —Roubal used hot 10% formalin which does not cause the severe contraction of worms, while I used cold fixative which causes contraction. However, the fixing methods do not affect hard parts, so I cannot explain why the maximum length of the anchors is larger in Roubal's specimens. In spite of this difference I am confident, having examined Roubal's material, that my specimens should be included in *L. squamosus*, particularly

Acanthopagrus at various localities. (L=maximum length; W=maximum width; N=number to Roubal (1981)). For abbreviations of localities see Fig. 7.

A. berda					*A. latus*	
Y (N=5)	L (N=10)	K (N=10)	BB (N=10)	DW (N=5)	BM (N=5)	PS (N=10)
226(209–282)	253(208–291)	248(208–282)	243(208–282)	229(208–266)	277(266–291)	237(208–266)
106(100–108)	106 (75–125)	110 (91–125)	106 (91–125)	105 (91–125)	97 (75–108)	97 (83–108)
121(115–125)	117(108–125)	120(108–133)	117(108–125)	118(108–133)	121(116–125)	115(108–125)
46 (43–47)	45 (41–51)	43 (36–47)	42 (38–45)	44 (41–47)	44 (41–47)	41 (34–45)
43	43 (34–75)	43 (36–47)	43 (41–47)	42 (41–43)	41 (36–45)	38 (30–43)
55 (51–57)	52 (47–55)	54 (51–57)	54 (51–57)	53 (51–55)	51 (49–53)	51 (45–55)
48 (41–51)	47 (45–51)	47 (45–51)	47 (45–51)	46 (45–47)	49 (47–51)	47 (43–49)
51 (47–53)	49 (45–53)	51 (47–53)	50 (47–53)	50 (47–53)	49 (47–51)	48 (43–51)
47 (45–49)	45 (36–51)	46 (41–49)	46 (41–49)	46 (41–49)	43 (41–45)	43 (34–47)
62 (59–63)	58 (53–63)	61 (57–65)	61 (58–63)	60 (57–61)	61 (59–63)	58 (51–63)
59 (55–63)	52 (45–57)	58 (49–63)	57 (53–61)	57 (53–61)	55 (53–57)	53 (41–46)
51 (45–55)	47 (36–55)	49 (47–51)	49 (47–51)	49 (47–51)	42 (34–51)	42 (24–51)
27 (24–30)	25 (18–30)	26 (24–30)	25 (24–28)	26 (24–28)	24 (22–26)	25 (20–34)
21 (20–24)	22 (18–26)	26 (24–30)	24 (20–30)	24 (22–24)	23 (22–24)	22 (20–28)

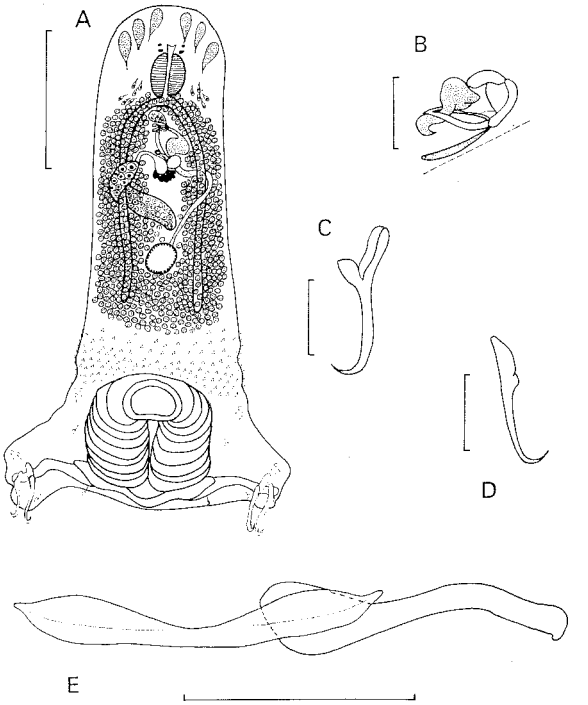


Fig. 5. *Lamellodiscus squamosus* Roubal. A. Entire animal, ventral; B. Copulatory sclerites, ventral; C. Dorsal anchor, ventral; D. Ventral anchor, ventral; E. Central and lateral crossbar, ventral. Scale lines: A, 100 m; B, 15 μm; C, D, 25 μm; 50 μm.

Table 5. Measurements (mean (range)) of *Lamellodiscus* on three species of *Acanthopagrus* at various localities. (L=maximum length; W=maximum width; N=number of specimens measured). For abbreviations of localities see Fig. 7.

Host		*A. australis*			*A. berda*			*A. latus*		
Localities		N (N=10)	CH (N=8)	B (N=10)	L (N=1)	BB (N=10)	DW (N=10)	BM (N=10)	BS (N=10)	CN (N=1)
Total	L	299(274–332)	574(422–665)	305(274–332)	291	314(274–357)	289(274–332)	314(249–357)	275(246–291)	332
Max. width		91 (75–100)	72 (54–97)	97 (91–100)	91	96 (83–108)	92 (93–100)	97 (83–100)	95 (83–108)	91
Opisthaptor	W	167(158–174)	183(103–249)	164(158–166)	158	159(149–166)	166(158–174)	163(158–166)	162(158–166)	174
Lamellodisc	L	71 (55–81)	91 (76–120)	67 (58–71)	61	77 (67–91)	66 (61–81)	70 (61–81)	66 (61–75)	61
	W	71 (65–79)	70 (49–86)	74 (67–81)	71	74 (65–81)	74 (71–81)	76 (71–81)	72 (65–81)	81
Central crossbar	L	84 (79–87)	89 (79–100)	83 (79–91)	81	80 (75–83)	81 (75–89)	83 (81–89)	82 (79–87)	81
Lateral crossbar	L	68 (65–71)	70 (58–83)	66 (61–77)	63	64 (61–65)	63 (61–65)	63 (61–67)	64 (61–71)	61
Ventral anchor	A	33 (28–34)	44 (41–47)	32 (28–34)	30	32 (30–36)	30 (26–34)	31 (30–32)	31 (28–32)	34
	B	31 (28–32)	25 (23–27)	31 (26–32)	30	31 (28–34)	30 (24–32)	30 (28–32)	30 (26–32)	34
Dorsal anchor	A	36 (32–41)	49 (33–56)	35 (32–38)	32	33 (30–36)	34 (32–35)	34 (32–36)	34 (32–36)	34
	B	35 (32–38)	34 (21–42)	33 (28–38)	30	31 (30–34)	31 (28–34)	31 (28–34)	32 (30–34)	30
Copulatory sclerites	L	29 (26–32)	—	28 (24–32)	30	29 (24–32)	28 (24–32)	28 (24–30)	29 (24–32)	32
Pharynx	L	27 (20–30)	37 (28–43)	27 (22–30)	28	26 (20–30)	30 (24–38)	28 (24–32)	27 (24–30)	30
	W	22 (20–24)	34 (26–38)	23 (22–24)	20	27 (20–45)	23 (18–32)	25 (24–30)	24 (20–26)	30

since some of my material comes from the same host and similar localities as Roubal's.

Differential Diagnosis. This species differs from the most closely related species *L. vaginalis* (see above) in the shape of the copulatory sclerites and vagina.

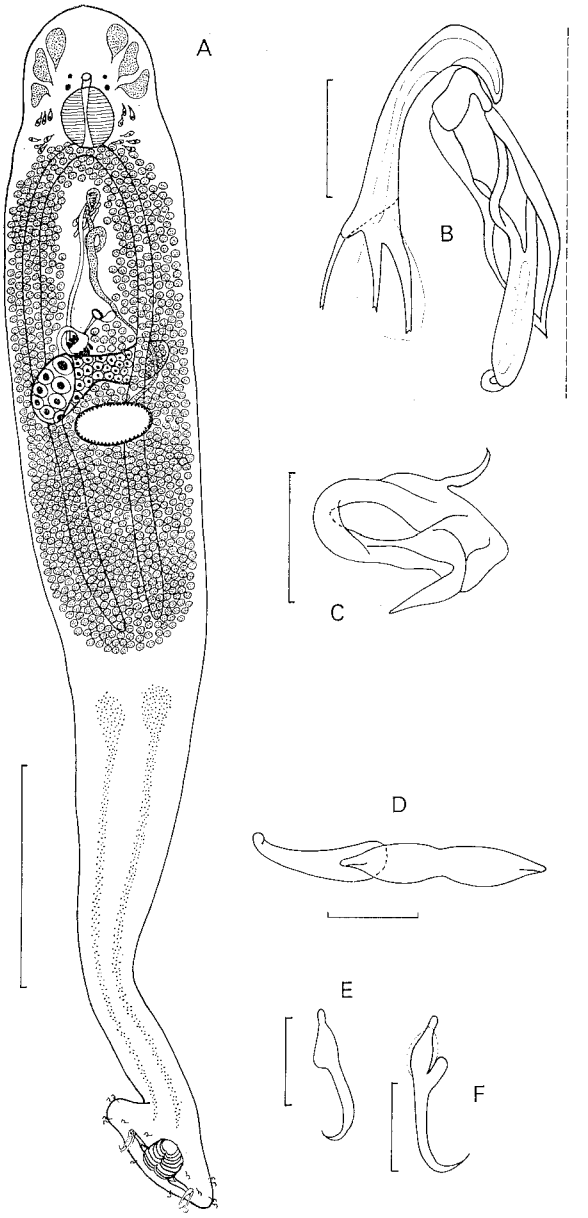


Fig. 6. *Lamellodiscus major* Murray. A. Entire animal, ventral; B. Copulatory sclerites, ventral; C. Vaginal sclerites, ventral; D. Central and lateral crossbar, ventral; E. Ventral anchor, ventral; F. Dorsal anchor, ventral. Scale lines: A, 250 μm; B–D, 25 μm; E, F, 20 μm.

Table 6. Measurements (mean (range)) of *Lamellodiscus major* on two species of *Acanthopagrus* at various localities. (L=maximum length; W=maximum width; N=number of specimens measured). Measurements of specimens from CH are according to Roubal (1981). For abbreviations of localities see Fig. 7.

Host		*A. australis*					*A. latus*		
Localities		E (N=10)	N (N=10)	CH (N=4)	B (N=5)	T (N=5)	MB (N=10)	PS (N=10)	CN (N=10)
Total	L	1042(747–1328)	838(664–996)	1051(768–1386)	946(872–996)	1054(830–1328)	946(581–1328)	1171(872–1577)	1150(872–1411)
Max. width		283(249–265)	293(249–332)	223(206–254)	266(249–291)	284(274–291)	258(249–291)	298(249–349)	280(232–332)
Opisthaptor	W	187(149–241)	182(149–208)	147(135–157)	186(166–208)	186(166–208)	179(149–216)	201(166–232)	186(149–249)
Pharynx	L	73 (61–81)	67 (61–71)	71 (63–87)	65 (61–71)	68 (61–75)	65 (61–71)	78 (61–91)	73 (61–95)
	W	81 (67–101)	75 (67–81)	74 (63–92)	73 (71–81)	73 (61–81)	76 (71–91)	83 (71–91)	78 (61–101)
Copulatory sclerites	L	75 (67–81)	74 (67–81)	—	71 (65–77)	74 (71–81)	78 (71–91)	80 (71–91)	82 (75–91)
Vaginal sclerites	L	46 (35–55)	41 (34–51)	—	36 (30–41)	40 (36–41)	41 (30–47)	41 (34–51)	43 (34–59)
Central crossbar	L	52 (41–57)	52 (49–57)	48 (45–50)	53 (51–55)	54 (51–57)	56 (51–61)	60 (51–73)	59 (51–67)
Lateral crossbar	L	40 (28–45)	40 (34–41)	37 (34–38)	40 (38–41)	40 (38–41)	43 (41–47)	43 (38–51)	46 (38–51)
Ventral anchor	A	29 (24–36)	28 (24–30)	29	27 (24–29)	28 (24–34)	30 (28–32)	30 (24–32)	31 (28–34)
	B	28 (18–34)	27 (22–30)	—	24 (22–28)	25 (18–28)	30 (27–32)	29 (18–32)	30 (28–33)
Dorsal anchor	A	28 (24–32)	27 (18–24)	35	28 (28–30)	28 (24–32)	31 (28–38)	30 (20–32)	30 (22–36)
	B	24 (20–34)	22 (8–30)	—	38 (22–32)	27 (20–32)	28 (24–38)	25 (12–32)	25 (12–32)
Lamellodisc	L	46 (41–57)	43 (36–47)	51 (42–65)	45 (41–47)	44 (41–47)	50 (41–57)	48 (45–57)	50 (45–55)
	W	43 (36–47)	43 (36–47)	35 (32–38)	43 (41–45)	42 (36–47)	44 (41–51)	47 (41–59)	47 (41–55)

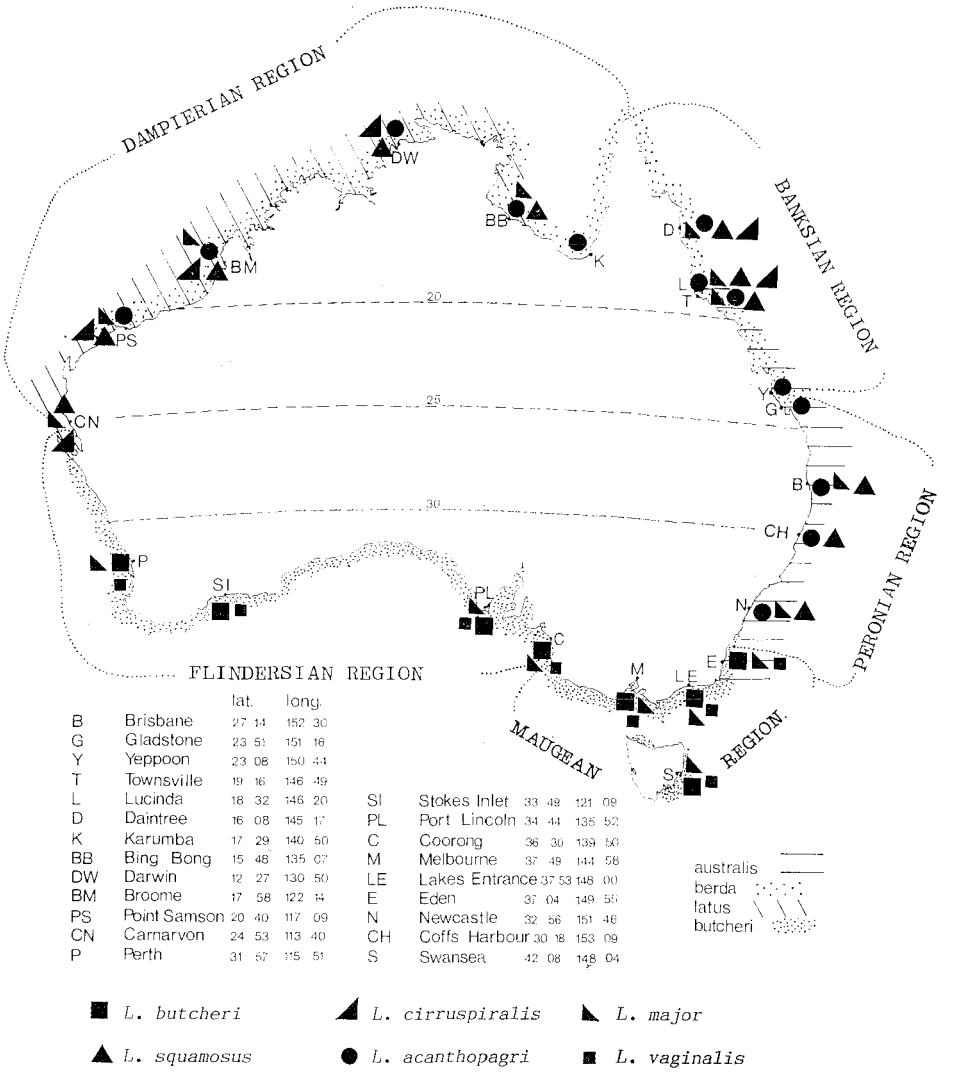
Lamellodicus major Murray

(Fig. 6)

Lamellodiscus major Murray, 1931, p. 498, pl. 20, fig. 3.
Lamellodiscus major Murray: Roubal, 1981, pp. 12, 13, figs 34–40.

Material. Nine hundred and seventy-five specimens collected. Site: Gill filaments. Hosts: *A. butcheri, A. australis, A. berda* and *A. latus.* Localities: Perth, Port Lincoln, Coorong, Melbourne, Lakes Entrance, Swansea, Eden, Newcastle, Coffs Harbour, Brisbane, Townsville, Lucinda, Daintree, Bing Bong, Darwin, Broome, Point Samson, and Carnarvon. See Table 10 for prevalence and relative densities; Fig. 7 for distribution.

Previous Records. An unknown number were found by Murray (1931) on the



		lat.	long.
B	Brisbane	27 14	152 30
G	Gladstone	23 51	151 16
Y	Yeppoon	23 08	150 44
T	Townsville	19 16	146 49
L	Lucinda	18 32	146 20
D	Daintree	16 08	145 17
K	Karumba	17 29	140 50
BB	Bing Bong	15 48	135 07
DW	Darwin	12 27	130 50
BM	Broome	17 58	122 14
PS	Point Samson	20 40	117 09
CN	Carnarvon	24 53	113 40
P	Perth	31 57	115 51
SI	Stokes Inlet	33 49	121 09
PL	Port Lincoln	34 44	135 52
C	Coorong	36 30	139 50
M	Melbourne	37 49	144 58
LE	Lakes Entrance	37 53	148 00
E	Eden	37 04	149 55
N	Newcastle	32 56	151 46
CH	Coffs Harbour	30 18	153 09
S	Swansea	42 08	148 04

Fig. 7. Distribution of six *Lamellodiscus* species around Australia.

Table 7. Measurements (mean (range)) of *Lamellodiscus major* on two species of *Acanthopagrus* at various localities. (L=maximum length; W=maximum width; N=number of specimens measured). For abbreviations of localities see Fig. 7.

Host		*A. butcheri*						*A. berda*		
Localities		P (N=10)	C (N=10)	PL (N=10)	M (N=10)	LE (N=10)	S (N=10)	L (N=10)	D (N=10)	BB (N=1)
Total length		892(706–1072)	760(664–913)	1424(1243–1702)	859(747–996)	884(706–1162)	1083(747–1325)	1065(830–1411)	1100(913–1245)	996
Max. width		264(249–291)	297(274–332)	153 (224–291)	289(249–332)	298(249–332)	309(249–332)	277(232–291)	274(208–307)	282
Opisthaptor	W	189(166–208)	206(183–208)	182 (166–208)	193(166–208)	204(166–216)	175(158–208)	192(166–208)	189(149–208)	208
Pharynx	L	70 (61–81)	70 (61–81)	81 (71–91)	62 (61–71)	64 (59–81)	81 (71–101)	73 (60–101)	84 (71–91)	61
	W	76 (61–91)	79 (67–91)	89 (81–91)	89 (81–91)	73 (65–81)	81 (44–101)	82 (71–95)	85 (71–91)	71
Copulatory sclerites	L	69 (61–71)	73 (41–81)	77 (67–81)	75 (71–81)	74 (65–81)	75 (61–81)	74 (67–81)	70 (61–81)	71
Vaginal sclerites	L	39 (34–41)	32 (24–28)	43 (32–55)	36 (30–41)	39 (30–49)	34 (24–47)	40 (32–47)	34 (30–41)	41
Central crossbar	L	50 (47–53)	52 (51–55)	53 (49–57)	52 (49–57)	54 (51–59)	56 (47–71)	54 (51–63)	56 (51–61)	53
Lateral crossbar	L	39 (36–41)	41 (40–45)	40 (36–43)	40 (38–41)	41 (38–47)	41 (36–53)	40 (34–43)	47 (41–51)	41
Ventral anchor	A	28 (26–30)	28 (26–30)	31 (24–36)	29 (24–30)	30 (28–34)	30 (26–34)	27 (24–32)	28 (20–32)	30
	B	29 (26–30)	28 (26–30)	28 (18–34)	27 (10–30)	30 (29–32)	29 (24–36)	24 (18–30)	26 (12–30)	30
Dorsal anchor	A	28 (26–32)	30 (24–36)	30 (24–34)	32 (30–38)	29 (22–32)	32 (26–38)	29 (24–34)	35 (30–41)	28
	B	23 (20–26)	25 (18–34)	25 (14–34)	27 (24–34)	24 (18–30)	28 (20–34)	27 (14–34)	33 (26–36)	20
Lamellodisc	L	45 (38–47)	49 (38–53)	49 (47–51)	50 (47–55)	47 (41–55)	45 (41–49)	45 (36–47)	50 (45–55)	42
	W	39 (36–41)	46 (41–51)	46 (45–49)	45 (41–55)	43 (41–47)	44 (41–49)	42 (36–47)	50 (47–55)	45

gills of *Acanthopagrus australis* from the Werribee River, Victoria. It is probable that the host was *A. butcheri* since *A. australis* does not range as far south as the Werribee River (Munro, 1949; Dunstan, 1965; and own observations, see Fig. 7). Roubal (1981) recovered six specimens from *A. australis* at Coffs Harbour, N.S.W.

Roubal's redescription is adequate and needs no additions. For measurements see Tables 6 and 7.

Discussion. My material is similar to *Lamellodiscus major* as redescribed by Roubal (1981) in every respect. This species was the most widely distributed *Lamellodiscus* species found in this study.

Differential Diagnosis. Lamellodiscus major differs from all other congeneric species in the large size of the body proper and the relatively small opisthaptor, as well as the complicated shape of the copulatory and vaginal sclerites.

Table 8. *Lamellodiscus squamosus* and *L. vaginalis*. Prevalence and relative density of infection on four species of *Acanthopagrus* at various localities.

Parasite species	Host species	Locality (for abbreviations see Fig. 7.	Relative density	Prevalence %
Lamellodiscus squamosus	*A. australis*	N	1.8	30.0
		CH	1.8	20.0
		B	.28	15.0
		T	.25	15.0
	A. berda	L	.38	10.0
		D	.13	7.5
		BB	.38	25.0
		DW	13.1	87.5
		BM	.2	17.5
		PS	.4	12.5
	A. latus	BM	.28	22.5
		PS	.45	5.0
		CN	.73	35.0
Lamellodiscus vaginalis	*A. butcheri*	P	18.7	97.5
		SI	3.6	27.5
		PL	5.6	55.0
		C	1.6	45.0
		M	11.0	87.5
		LE	9.3	82.5
		S	92.4	80.0
		E	19.9	85.0
	A. australis	E	1.1	20.0

Host Specificity and Zoogeography

Lamellodiscus major was recorded from all four host species but it showed a clear prevalence and relative density preference for *Acanthopagrus butcheri* (Table 10). *Lamellodiscus acanthopagri* and *L. squamosus* both infected three host species with no obvious host preference (Tables 8 & 9). *Lamellodiscus butcheri* (Table 9), *L. vaginalis* (Table 8) and *L. cirrusspiralis* (Table 10) were each recovered on two host species. The two former parasites exhibited a strong preference for *A. butcheri* while the latter showed no apparent host preference. The fact that all parasites were found on at least two host species is strong evidence that Australian bream are very closely related.

Lamellodiscus major was the most widely distributed species in this study. It was recorded from every zoogeographical region (see Fig. 7). Both *L. butcheri* and

Table 9. *Lamellodiscus acanthopagri* and *L. butcheri*. Prevalence and relative density of infection on four species of *Acanthopagrus* at various localities.

Parasite species	Host species	Locality (for abbreviations see Fig. 7.	Relative density	Prevalence %
Lamellodiscus acanthopagri		N	1.5	35.0
		CH	109.2	54.5
	A. australis	B	.63	27.5
		G	3.5	42.5
		T	.53	20.0
		Y	.03	2.5
		L	.53	15.0
		D	.8	25.0
	A. berda	K	3.2	30.0
		BB	.13	7.5
		DW	11.2	80.0
		BM	.33	15.0
		PS	.63	10.0
	A. latus	BM	1.7	35.0
		PS	1.3	17.5
Lamellodiscus butcheri		M	12.8	97.5
		LE	9.2	80.0
		S	13.0	77.5
	A. butcheri	E	28.3	97.5
		P	11.9	90.0
		PL	2.0	27.5
		SI	5.9	77.5
		C	9.6	97.5
	A. australis	E	.78	25.0

Table 10. *Lamellodiscus major* and *L. cirrusspiralis*. Prevalence and relative density of infection on four species of *Acanthopagrus* at various localities

Parasite species	Host species	Locality (for abbreviations see Fig. 7.)	Relative density	Prevalence %
Lamellodiscus major	*A. butcheri*	P	.25	12.5
		PL	2.1	12.5
		C	.33	15.0
		M	10.6	52.5
		LE	4.6	40.0
		S	1.2	17.5
		E	.03	2.5
	A. australis	N	.38	27.5
		CH	.15	5.0
		B	.18	15.0
		T	.45	17.5
	A. berda	L	.5	10.0
		D	.33	7.5
		BB	.03	2.5
		DW	.08	7.5
		BM	.08	7.5
		PS	.15	7.5
	A. latus	BM	.25	20.0
		PS	3.0	57.5
		CN	2.0	45.0
Lamellodiscus cirruspiralis	*A. latus*	BM	2.4	35.0
		PS	.68	12.5
		CN	1.3	27.5
	A. berda	L	.05	5.0
		D	.1	5.0
		DW	.03	2.5
		BM	1.4	25.0
		PS	1.9	45.0

L. vaginalis are cold water species, restricted to the Flindersian and Maugean Regions. Both *L. acanthopagri* and *L. squamosus* range from the Peronian Region in the south to the Dampierian Region in the northwest. *Lamellodiscus cirrusspiralis* is a warm water species, restricted to the Banksian and Dampierian Regions.

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